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ORGAN OF THE MUSHROOM GROWERS' ASSOCIATION

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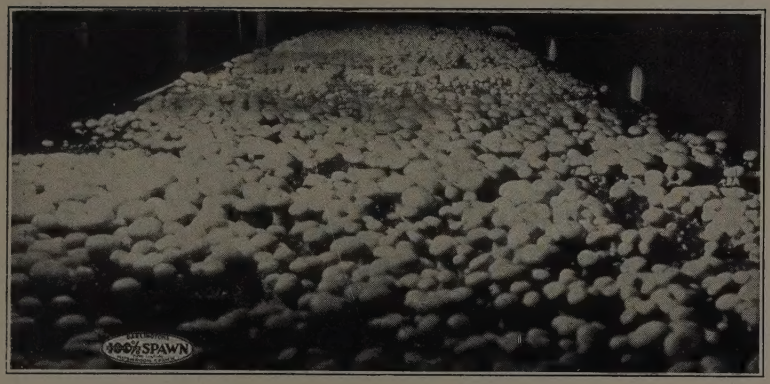

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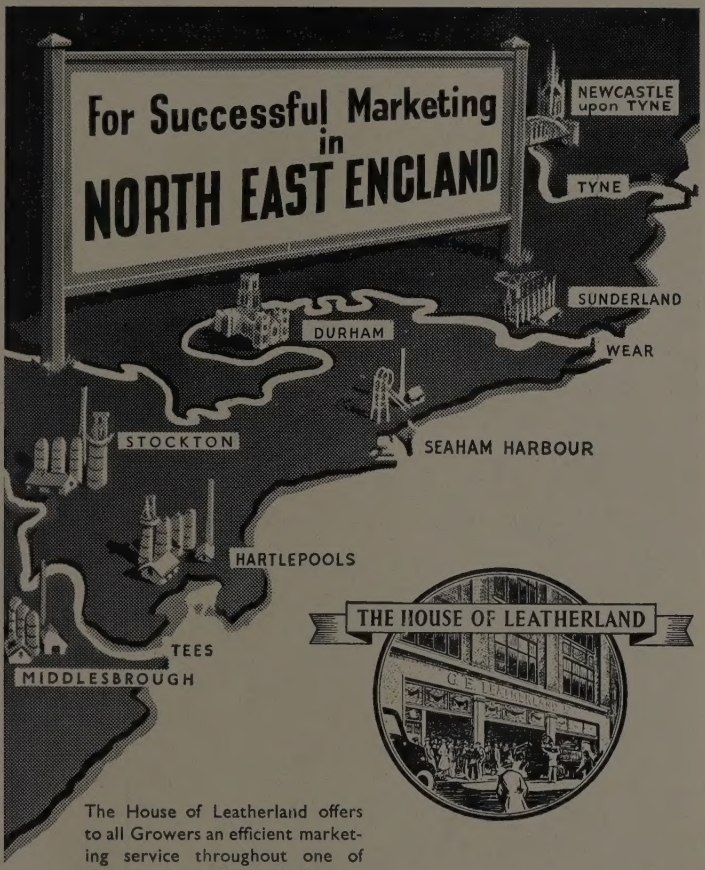

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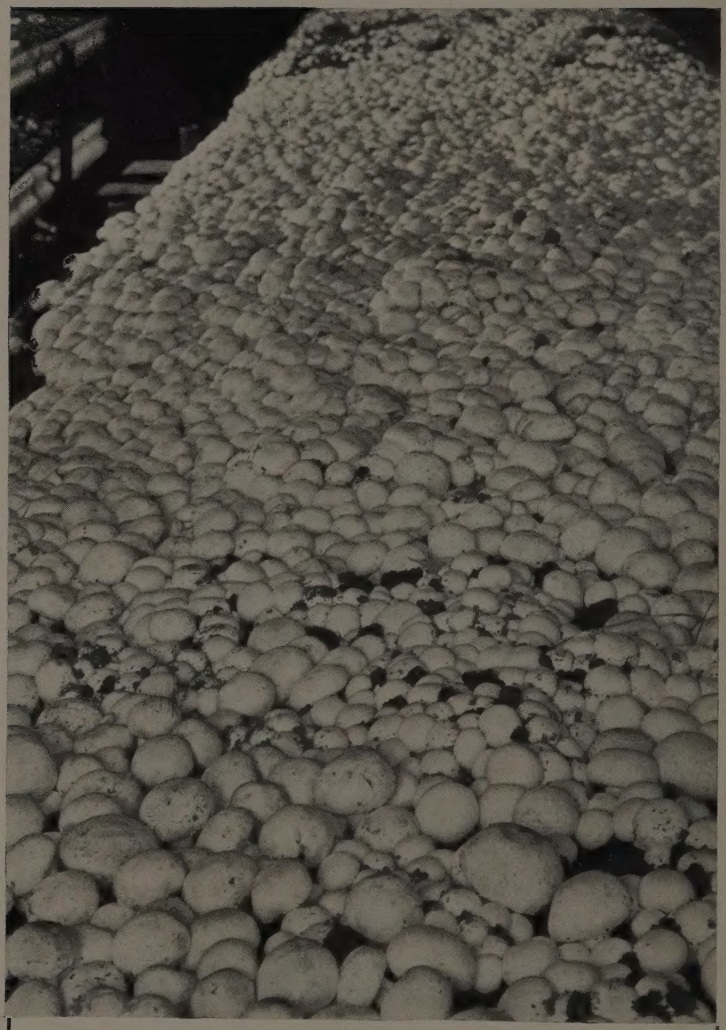

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2. **Dusting.** Use DEDETANE 10% Dusting Powder giving applications as outlined above.
3. **Smoking.** Use MURFUME DDT SMOKES. The cones are particularly recommended for small houses which are reasonably airtight.

Please write for your copy of our new price list and Mushroom Growers' leaflet.

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THE

JULY 1949

BULLETIN No. 16

No responsibility can be assumed by the Editor, the Editorial Board, or the Mushroom Growers' Association, for statements made or views expressed in this Bulletin, or for any advertisements included in this publication.

EDITORIAL

The **Annual Luncheon** and **General Meeting** of the members of the M.G.A. has been fixed for the **30th November,** this year, and will take place at the Restaurant Frascati, Oxford Street, London, as usual.

Members will be interested to learn that it was unanimously decided by the Executive Committee to invite **Dr. W. K. Slater,** recently appointed Secretary of the Agricultural Research Council, to be our Guest of Honour at the Luncheon. He at once accepted our invitation.

It was Dr. Slater who, in the early days of the M.G.A., wrote to the Secretary and suggested a meeting to discuss the problems facing the Industry. At that time he was Secretary of the Agricultural Improvement Council and since then he has maintained the closest contact with the activities of the Association. It was no mere formality when we had the pleasure a short time ago of writing and congratulating him on his new appointment.

It is with very great pleasure and no little pride that we announce the Research Fund has 'topped' the £2,000 mark .... has in fact reached £2,280. No mean effort for a relatively small Industry.

The target is £2,500.

There was no doubt about the success of the Open Day, and a great deal of this was due to the good nature and tolerant friendliness of the members who made the effort to attend. It seems obvious that this will now become a popular annual event, although Dr. Edwards and his staff may not be able to produce a 'rabbit' of the calibre of the synthetic formula every time!

FROM THE SECRETARY

NEWS FROM M.G.A. HEADQUARTERS

Glasshouse Produce Committee. During the March meeting of the G.P.C., members were asked which crops they considered of most importance to the well-being of the Glasshouse Industry. They decided that tomatoes, cucumbers, lettuce and **mushrooms** were without doubt the main items.

Yaxley 391. Will members please note that the telephone number of the Secretary is now Yaxley 391 ? Alteration to the M.G.A. letterheads will be made in due course.

Potassium Permanganate. Orders for reasonable quantities can now be delivered promptly and the strict rationing of supplies has been abolished.

M.G.A. Library. Monsieur P. Lombrage has presented to the Library a copy of *Le Chauffage Electrique du Sol en Horticulture.*

Loss in Transit. The intervention of the M.G.A. in a dispute between a grower and the Railway Executive has resulted in a decision in the member's favour.

Membership. The M.G.A. now has 270 grower-members and 133 honorary members, including growers and scientists from all parts of the globe. These figures do not include those members who have forgotten to renew their subscriptions . . .

Bulletins. In view of the importance of Bulletin No. 15 a large number was ordered and we hope to be able to satisfy the demand for some time. A few copies of Bulletins 7, 12, 13 and 14 are also in stock.

Timber. Few members appeared interested in the announcement on page 69 of the last Bulletin concerning timber. Can it be that growers have enough timber, or is it that they have given up trying for an allocation in despair ?

Canning. A large firm of canners enquire whether any growers are interested in supplying them with a total of 3,500 lbs. of best cups, both closed and open, per week. Will growers interested in this type of contract please write to the Secretary?

Honorary Treasurer Resigns

ILLNESS OF Mr. PERCY MAJOR

All members will learn with sincere regret of the resignation from office of Mr. Percy C. Major, Honorary Treasurer of the M.G.A. since its inception in 1945.

Mr. Major wrote to our Chairman : " In view of the recent breakdown in my health, which has resulted in my having to retire from any further occupation, I am most regretfully obliged to resign the Honorary Treasurership of the M.G.A. This has been a hard decision to make because the work has been most congenial and has been carried on in the company of a group of very good fellows, to whom I send my best wishes."

General Sir Oliver Leese has replied as follows : " It is with very real regret and sadness that I have received your letter sending me your resignation from the position as Treasurer of the M.G.A. I feared you might be compelled to do this – and I am very sorry that it should fall to my lot as Chairman to have to write and accept.

" You have done so much for the M.G.A. –ever since its start—and I can assure you that, for many of us, the meetings of the M.G.A. Executive Committee will never be quite the same thing without your guidance and quiet wisdom and unfailing enthusiasm and good humour.

" You have indeed done a good job for the M.G.A. and in this unhappy task of accepting your resignation I hope you will allow me to express to you the heartfelt thanks of the M.G.A. and their best wishes to you for an early recovery to your old self. You have indeed given a fine example to us all in your stewardship of our affairs and we wish you and Mrs. Major all happiness."

And so say all of us.

(Mr. Major is the proprietor of PIXIE CULTIVATED MUSHROOMS, Duston, Northampton, and Managing Director of DE LA PRÉ COMPONENTS LTD., Northampton).

MUTUAL AID
QUESTIONS & ANSWERS

It has been felt for some time that three months delay between questions and answers is too long. From now on questions and answers will be printed together, and members are asked to co-operate by sending in their views on any question or any answer.

Q. 111. *With reference to your subscription notice for 4 guineas I would like to point out that I already subscribe to the local branch of the National Farmers' Union and would therefore like to know whether part of this is paid to another branch of the N.F.U.?*

(1) You are paying subscriptions to two separate branches of the N.F.U., namely London Branch and your local Branch. NOEL D. HARDING.

(2) National Farmers' Union rule 23 (3) states: "If any person is a member of more than one of the local or specialist branches of the Union his annual subscription shall be increased by one guinea for each additional branch after the first." EDITOR.

Q. 112. *Can you tell me the number and best position for wall and roof ventilators for a mushroom house 80 ft. long, with two sets of beds 4 tiers high and 6 ft. wide? Is it of any advantage to fit exhaust fans?*

Your wall ventilators should be spaced every 10 ft. and so arranged that the ventilators on the opposite walls are "staggered" to prevent cross draughts. Each ventilator should be about 24" × 18" with a flap, and as near the floor as possible. The best roof ventilator is the louvred type running the whole length of the house and extending 12" on each side of the ridge with well-fitting flaps which could be up to 4 ft. long. It is an advantage to fit exhaust fans but it would be a better proposition to have an ordinary 16" blade fan, for which there is more than one use. NOEL D. HARDING.

Q. 113. *I intend to use electric heating in a new house. What is the best method—(1) Low voltage strip heating, (2) Tubular heaters, or (3) Combined electrical and water heater?*

See article on "Electricity in Mushroom Houses" in this issue. EDITOR.

Q. 114. *Where can I obtain plans or specifications for mushroom houses?*

(1) There are no standard plans available; suggest you read Dr. E. B. Lambert's paper on "Air Conditioning Requirements in Modern Mushroom Houses." There is a tendency here to-day to have houses of about 1,000 sq. ft. of bed area. FRED. C. ATKINS.

(2) If you mean a house specially designed for mushroom growing such as the standard American type you will find some specifications in "Cultivation of Mushrooms" by Bewley and Harnett (M.G.A. Library). NOEL D. HARDING.

Q. 115. *What types of soil sterilizer are there available? Which do you recommend?*

There are several types available: Electric—see Bulletin 13. Steam—either Messrs. George Monro or Messrs. W. Darlington will be pleased to help. FRED. C. ATKINS.

Q. 116. *When composting fresh stable manure, what type of starter is best to use, the amount of gypsum, the amount of phosphates, and the amount of urea (if any)?*

(1) There are several 'starters' on the market such as Adco "M" and "Seegro." Adco "M" is widely used by growers I believe but it is inclined to break up the straw too much; "Seegro" doesn't so much. Both are used as a means of producing heat within the stack. NOEL D. HARDING.

(2) The addition of phosphates, urea, or other fertilizers depends on the initial state of the manure. If very light and strawy, e.g., racing stable manure,

the addition of nitrogen in the form of urea, dried blood, poultry manure, nitrochalk or Adco " M " will probably be beneficial. The quantity to be used depends entirely on the quality of the manure.

SUGGESTIONS :

Adco " M " 1 cwt./1 ton straw	=	3 tons wet.
Blood 3 cwt./1 ton straw	=	3 tons wet.
Urea 1 cwt./1 ton straw	=	3 tons wet.

The use of *superphosphate* has been suggested, added at the last turn, but there is no information available about the type of manure which benefits most. Gypsum is beneficial to the compost and it is advised to add 28 lbs. per ton of manure —Dr. Pizer recommends at the first turn. DR. R. L. EDWARDS.

Q. 117. *Are the waste products from penicillin production of any use as a source of nitrogen in " pepping up " long-straw manure for mushroom composts ?*

We have been advised that waste mycelium felt from penicillin production is offered by the Distillers Company (Biochemicals) Ltd., Fleming Road, Speke, Liverpool 19, at a price not exceeding 30 - per ton. They produce 6,000 tons (wet weight) annually. It contains 90% of water but 40% of the total solid matter is protein, and it may be suitable for addition to long strawy manure such as racing stable manure to supply additional nitrogen.

The manager of the Research and Development Division at Speke, Mr. Hastings, would be willing to co-operate in experiments on the use of this material. If you are interested would you kindly write to him direct.

I suggest that 2 tons of the wet felt could be added to 1 ton of racing stable manure. No addition of water would be necessary ; or experimentally 5 tons of the wet felt could be added to 1 ton of dry straw, no water being added. This would produce compost equivalent to 4 or 5 tons of stable manure. I also suggest that the felt would be worth trying in either of these ways if it is obtainable at £1 per ton or less. DR. R. L. EDWARDS.

Q. 119. *Is it possible to grow mushrooms without soil ? I hear that it is done in South Africa, but cannot trace the source.*

(1) It is possible to grow mushrooms without soil, but it is only worth trying as an experiment. How do you propose to retain moisture in the compost ?
NOEL D. HARDING.

(2) We have no information regarding the growing of mushrooms without soil, except that when poultry manure is mixed with soil, fermented and then spawned, it is said to be unnecessary to ' case ' with soil.

Normal culture requires 1" of soil on top of the compost : (1) to hold the mushroom upright (2) to prevent the surface of the compost from drying out (3) to provide a moist medium in which the mycelium can ramify (4) to release moisture slowly by evaporation, encouraging the mycelium to fruit. FRED. C. ATKINS.

Q. 120. *I am finding with my last crop that the mushrooms are forming directly on top of the compost underneath the soil, and that the mycelium does not spread into the soil. What is the reason ? To add to the confusion, some mushrooms have even formed through holes in the bedboards, and picking is done (as it were) standing on one's head.*

Any one or all of the following are probably a fault ; unsuitable soil, soil too thick, soil too fine which with watering will form a crust and cut off the supply of air to the mycelium and retard growth. It is not uncommon for mushrooms to grow out from the underside of beds or between compost and side boards.
NOEL D. HARDING.

Had a pH test recently? FRED. C. ATKINS.

Q. 121. *Can you let me have any information on the short method of composting expounded by Dr. Sinden on his recent visit ?*

Unfortunately no information of this method is yet available, but Dr. Sinden will let us know the moment he publishes his paper on it. FRED. C. ATKINS.

Q. 122. *Can you tell me whether a system of electrical soil heating is considered practicable in mushroom beds ?*

Q. 123. *Are the results obtained by any form of heating by electricity satisfactory ? Could we have an article on all possible methods ?*

We have very little knowledge of soil heating with reference to mushrooms, but I am under the impression that it can be done and in fact is being done. The Swiss heat their beds in this manner and we are trying to get detailed information. The current is transformed from the mains to low voltage and high amperage. From the transformer to the beds the energy is transported by wire copper unshielded strips to avoid loss of heat energy. Inside the heating layer (at the bottom of the compost) the current passes through narrow copper wires which heat up easily. Growers using this method find it very cheap in countries where electricity IS cheap, and they counteract the loss of humidity by running the wires through wet sand or some other suitable medium. It is a form of heating which sounds ideal, getting the right amount of heat to the right place.

Space heating is the present method used throughout the Industry, but many growers are realising it is wasteful. Leading growers are using electrical heaters to assist their hot water pipes for peak-heating. Up to 48 hours this is very satisfactory. Some are using electric heaters alone and although satisfactory this can be expensive. EDITOR.

Heating the beds by electricity has been tried, unsuccessfully. Current consumption is tremendous and think of the time and trouble it would entail when emptying and filling. NOEL D. HARDING.

Q. 124. *What is your opinion on the sterilization of casing soil by formaldehyde? How does one set about it?*

This method of sterilizing casing soil has advantages and disadvantages over steam sterilizing. This is the only method for growers who do not possess a steam sterilizing outfit. It is quicker, easier and cheaper than steam. It will kill the spores of Mycogone. The treated soil must not be used for a fortnight.
NOEL D. HARDING.

Q. 125. *Can you tell me what is the best commercial way of insulating the ceiling of mushroom houses roofed with wood and felt?*

(1) The best way of insulating the ceiling of a mushroom house (wood and felt roof) is to secure corrugated asbestos sheets (leaving a 2" air space) on the outside of the roof and flat asbestos sheets on to the rafters inside. Both corrugated and flat sheets are off permit but very difficult to obtain at a reasonable price.
NOEL D. HARDING.

(2) Your roofing material of wood and felt does not possess good insulating qualities as you will have found out. Your best plan would be to fix a false ceiling of asbestos sheeting ventilating this space so that a current of air can be passed through between the false ceiling and the roof. An alternative to asbestos would be a thick layer of sawdust laid on top of a false roof. Another method is to erect a simple slanting roof over the house so that a current of air can pass between this and the roof proper. EDITOR.

Q. 126. *I have some mushrooms, the caps of which appear to be eaten away in saucer-shaped fashion, the eaten-away part having a shiny glass-like surface. I cannot see any life on the affected part, even with a hand lens. What is the cause? In 12 years I have never seen this peculiar effect before.*

From your description it appears that your mushroom have Bacterial Pit but Verticillium produces similar symptoms. In the absence of a sample it is difficult to diagnose.

Bacterial Pit is caused by inadequate drying of mushroom caps after watering and too acid a soil won't help matters. NOEL D. HARDING.

Q. 127. *Would some grower advise me on the best type of pressure sprayer for general use on my farm of 4,200 sq. ft. of indoor beds in darkened mushroom houses?*

You can't do better than use an "Eclipse" bucket sprayer holding 5 gallons of solution. Fitted with a long length of hose, lance and Haw's rose, two people can spray insecticides and fungicides, and with lance and nozzle (supplied with outfit) two can spray formaldehyde and good-quality creosote.
NOEL D. HARDING.

(2) For spraying liquids Messrs. W. T. French & Sons Limited, Mysto Works, Birmingham 16, do a hand sprayer at £8 10s. 0d. (6 gallons) and one at £9 10s. 0d. (10 gallons). I have seen both these in operation on large mushroom farms and they do the work with ease. If you want a powder duster Messrs. Geo. Monro's 'Fury' duster is simple, efficient and costs £8 10s. 0d. EDITOR.

Q. 128. *How much wheat straw is used per week (or p.a.) to litter one horse in an average commercial stable?*

Normally one bale or 90 lbs. of straw. J. WHARTON.

Q. 129. *What is meant by the American method of pasteurization? Are both air and bed temperatures raised to* 140° *F.? Does this destroy all insect life? Or must we still fumigate with sulphur?*

I imagine that if it means anything the "American Method" is (1) the introduction of live steam to insure a peak heat and (2) the judgment of duration by frequent pH readings. The average *bed* temperature is held near 140° F.; the air temperature is probably 15° lower. Most insects are destroyed except at floor level but fumigation with Gammexane or Azobenzene should look after them; sulphur is no longer very popular. FRED. C. ATKINS.

Q. 130. *Is there any authority for the use of a blow-lamp on bed boards? My insurance company is disputing a claim for damage caused by fire.*

"The Cultivation of Mushrooms" Bewley and Harnett. In this work, Dr. Bewley, Director of Research, Cheshunt Research Station, states clearly that he advocates the use of blow-lamp treatment on bed boards for prevention of disease.

Bulletin 34, "Mushroom Growing" H.M. Stationery Office. In this official work on mushroom growing, the author, Dr. Ware, also recommends the blow-lamp treatment of bed boards. EDITOR.

PUZZLE CORNER: What is the maximum cropping area one man can manage per annum without help of any kind? In other words can one man working alone make a reasonable living out of mushroom growing?

Extract from the Review of Applied Mycology, March, 1949.

DACTYLIUM IN DENMARK

Early in May, 1948, attention was drawn to a mushroom disease characterised by the development overnight of a white gossamer coating covering the fruiting bodies and looking almost like rime. It was full of conidiophores containing numerous conidia of *Dactylium dendroides* . . . . . According to W. Christensen, the onset of the disease is promoted by moisture condensation in conjunction with cold air, an unavoidable condition in houses heated exclusively by means of hot air. Severe attacks in summer cultures do not develop until September, when warm dry nights alternate with cold nights and ventilation is freely admitted during the latter. Infection appears to originate for the most part from overwintering mycelium on mushroom remnants in the soil. Strict hygiene in the beds is therefore the most important precaution. Soil disinfection with formalin (1 in 9) is usually recommended for direct control, but Kligman has reported good results from the use of chloropicrin in the United States, while Treschow's method for the extirpation of *Mycogone perniciosa* by one or two applications of 1 litre Bordeaux mixture (1-1-50) per square metre between 'flushes' should also be tested. Before new cultures are laid down the houses should be fumigated with sulphur (8 kg. per 100 cu.m).

N. F. BUCHWALD: Mushroom Mould observed in Danish mushroom cultures, *Gartnertidende*, lxiv, 1948.

EXTRACTS FROM

A Mushroom Grower's Diary

April 12. "What kind of loam do I get to grow mushrooms in?" writes a beginner. It seems he had never heard of compost.

April 18. A friend recently took delivery of a new car. On opening the bonnet he found displayed on a large card the legend "Unfit for Export." He has since wondered which of the faults was the one the importer might criticise.

May 5. According to the authorities the M.R.A. Open Day has been a success. Its greatest value, to me, was its opportunity to meet other growers and to exchange ideas. I would like to see any future event of this nature combined with a trades' show at which commercial exhibits of everything likely to be of interest to Mushroom Growers could be seen at one time.

May 12. Two growers, some 250 miles apart, report a similar trouble. After one or two very poor flushes the casing is full of growth but all mycelium has gone from the compost. Soils are widely different, though the thick growth in one full of humus is not unexpected. One impression is that in some way air has been prevented from entering the compost at a critical growing stage. Another explanation might be a too dry compost followed by a soil of high moisture content. In this case I should expect the mycelium to leave the droughty compost for the soil humidity.

June 2. All three synthetic composts now running are attacked by fly. Yet there are no flies in eight other houses cropping off stable manure. All eleven had Gammexane.

June 3. Results of a number of tests tend to show that Bean straw, as part base of a synthetic compost, does not produce a happy medium for fruiting, though mycelium runs well.

June 6. For once no mushrooms for a holiday. At Easter I was snowed under and took a bad price. Yet I feel defeated. Why no mushrooms for two or three days from a gross area of 20,000 sq. ft.?

June 7. I am still as certain as ever that some obscure outside condition has a large influence on cropping. How else can one explain why, at any season of the year, pinheads in several houses at various ages of crop sometimes grow very slowly and sometimes too quickly? During the past week they have grown slowly in *hot* weather.

June 8. A youth in khaki, wanting to go in for mushrooms in a big way, complains of difficulties in composting. For ten minutes I tried in vain to discover his methods. What was the size of his compost stack? What kind of manure? How wet was it, etc.? He was all reluctance, giving no facts. He talked ignorantly about pH, bacteria, compost moisture and quality, and mushroom nutrition, but he would tell me nothing about the compost except that it would not heat. After half an hour of further endeavour I whittled down the whole problem to a straight question "how much manure did you actually buy?" His answer was illuminating "one kitbag full."

Fred. C. Atkins pleads for . . . . . .

COMMONSENSE GRADING

PROPOSALS " UNDULY COMPLICATED "

Growers have been advised by Mr. Victor Collins, M.P., Chairman of the Parliamentary Labour Party's Horticultural Group, to realise that growing, wholesaling and retailing are not three industries but one —and to accept the fact that successful distribution starts with the grower. There can be no real improvement, says Mr. Collins, until the distributor can rely on good quality articles of recognised standard grades.

Every grower is constantly striving to improve the quality of his produce, and no one in his right mind believes we are happy when we have to send seconds to market. But whether or not we growers want recognised standard grades is a matter open to much doubt. Nobody on the growing side of the mushroom industry, as I have previously reported, seems very excited about the proposals of the Harding Grading Committee. But do we all clearly recognise the fact that unless we agree on standard grades we may have standardisation thrust upon us ?

When a gallant " Captain " chooses to grow mushrooms in " Battle " and writes of his wish to " cross-swords " with me when I venture to criticise the arbitrary proposals of that Committee—of which Captain Few was a member –I refuse to be intimidated.

What is the substance of his argument ?

1. What can we do beyond complaining to any grower who abuses the " Packed to M.G.A. Standards " Mark ? We might advise Wholesalers to ignore this particular grower's claims—" blacklist " him. I have not given the matter much real thought, but I do honestly confess that I would rather drop the Mark than institute inspection and prosecution. What sort of people does he think we are ?

2. Capt. Few ridicules my suggestion that mushrooms with veil unbroken and cap diameter less than $\frac{3}{4}$" be referred to as " buttons." All the salesmen with whom I have discussed this definition agree with me—and in any event I was simply attempting to differentiate between the Committee's " buttons " and their closed " cups " ; at present the only difference is that an extra quarter-of-an-inch on the stalk is permitted !

3. Scorn is poured on my request for " cups " to be allowed a maximum cap diameter of 3", as opposed to the Committee's $2\frac{1}{2}$". I have consulted a number of Salesmen outside London, and they agree with the Committee. So $2\frac{1}{2}$" it is !

4. " My goodness !" exclaims my critic when I suggest no size restrictions at all on " flats." On second thought I might transfer them to the Other Grades category ; they are not very fine examples of our art—even if I find them the tastiest of the lot !

The lack of interest displayed by the grower members of the M.G.A. is wrongly interpreted by Mr. Harding as acceptance of the proposals *in toto*.

Let him tackle a few growers personally and admit his error ! It is regrettable, of course, that the average grower dislikes letter-writing, and prefers to concentrate on his main job of growing. But if he fails

to register his protest *now*, he must not blame anyone but himself if the Harding Committee's proposals are adopted—and enforced by legislation!

Several growers when challenged by me have retorted: "Why need we grade anyway?" So long as demand exceeds supply we may have no difficulty in disposing of all our mushrooms without any serious attempt at grading. But our experience last Easter week-end, when supply exceeded demand—which we should realise is the objective of the Minister of Food, and the ultimate result of his indiscriminate encouragement of imports—only those mushrooms which Salesmen have come to know are carefully graded will fetch top prices.

We can grow mushrooms of finer quality than any imported; but only the best Continental mushrooms reach our markets—and so depress them—and they will continue to upset prices so long as we fail to grade to standards which can be relied upon to indicate the superior nature of the home-grown article.

The mistake we are probably making is to regard grading as something highly complex and expensive. What we want, surely, is a *definition* of two or three main grades; the rest of our produce can go ungraded. That (and no more) is what I expected when I voted for the establishment of a Grading Committee to devise "a recognised method of packing"—a method which would *encourage* us to grade. If the Committee's proposals give us any encouragement it is nullified by threats of prosecution for "infringements."

Capt. Few says he believes in studying these questions as far as possible from the Salesman's angle, whereas the Committee's proposals are "completely satisfactory" only to "the retail trade." What *do* the Salesmen say? Broome and Green Ltd. were the only salesmen to supply the Committee with detailed comment on its proposals.

My comment here is that if the M.G.A. wants to reach some measure of agreement among us (who will have to do the grading, after all), it must make the proposals as reasonable and as acceptable to us growers as it can, even if the wholesalers and retailers are not *completely* satisfied.

I did as Capt. Few commanded: I consulted a number of market salesmen outside London—all M.G.A. members and all preferring reliably-graded produce. Their comments included: "Each grower should retain his own individuality, packing to suit his own particular markets—not to suit some officious association!" And "too fine grading is unnecessary and would serve no useful purpose." And "we are more strongly in support of simplification of grading and packing, than the more elaborate scheme proposed." And "is not the Association unduly complicating the issue?"

In the light of their subsequent comments, and after very considerable thought on these matters, I now submit the following alternative to the Harding Committee's proposals:

SUGGESTED GRADES

Closed Cups: Membrane intact—and likely to remain so for 24 hours.

Open Cups: Membrane breaking or just broken.

Flats: Cap forming letter T with stalk.

In all three grades the cap diameter to be 1″—2½″ (with ¼″ permitted margin) and visible stalk not to exceed 1″.

There is now scope for modification to suit individual markets. Perhaps in London one might sub-divide into No. 1 Closed Cups (caps 1″—1½″). No 2 Closed Cups (caps 1½″—2″). No. 3 Closed Cups (caps 2″—2½″). And the same with the Open Cups, though expansion while travelling in warm weather would complicate matters.

Any other grades might well be left to the initiative and enterprise of the individual grower. " Broilers " (flats plus), " Buttons " (super pinheads) and " Diseased " (if we're honest) all suggest themselves—or simply " Ungraded." The Wholesalers, by the way, would prefer us to call Flats Opens, but might not this term be confused with Open Cups?

SUGGESTED PACKS

Items 1 to 10 to be accepted, subject to these observations :

5. As the dye from blue paper lining sometimes discolours the mushrooms, and as *any* lining reduces ventilation, it might be advisable to dispense with paper.

7. Opinion appears to be unanimous that the maximum weight of a chip should be 4 lb., and there is a distinct preference in several markets for 2 lb.

10. Date of despatch is surely unnecessary? Delete reference to " The Mark," for reasons to be given.

SUGGESTED MARK

There are objections to a " B.C.M." mark, and I suggest the whole idea is dropped :

(*a*) P. & T. Fitzpatrick Ltd., of Liverpool, tell me this abbreviation denotes specially graded and packed Celery grown in Lincolnshire.

(*b*) Such a mark, to be effective, would have to be policed—and who wants that?

(*c*) Wm. Morgan & Co. Ltd., of Cardiff, refer to the penal clauses in these words : " We have similar trouble in another branch of our trade. There is no need for one section of a business to set up as judge and jury over the rest. The more simple the scheme, and the less talk of penalties, the better."

MEMBERS' ADVERTISEMENTS

FRESH LONG RACEHORSE AND STUD STABLE MANURE. Reasonable prices per ton for delivery direct to mushroom fa ms. D. Griffiths, Moulton, Newmarket, Suffolk.

FOR SALE : —One Robin Hood Junior Boiler (4 sections), to heat 412 ft. of 4″ pipe, 530 sq. ft. radiation approx. 76,000 B.T.U. Price : £16 0s. 0d. Mushroom Research Association, Yaxley, Peterborough.

WANTED : —Assistant Foreman for mushroom farm near Colchester. Age 25-45, keen and willing to learn. Excellent references required and interview. Write Box A, Mushroom Growers' Association, Yaxley, Peterborough.

WATERING PROBLEMS

McGREGOR BULLOCH DESCRIBES A NEW GAUGE

Although mushroom-growers are never at a loss for an argument on the finer points of cultivation, watering of the casing-soil before and during cropping is, and always has been, the operation least understood and most feared, and hence the most controversial.

A grower may have had a lifetime of practice, but there is no doubt that it is impossible for him to water exactly as he should, or even as he intends to do on any given occasion. Factors responsible for this inconsistency are, to name a few, atmospheric humidity, variable pressure in the water-supply, faults developing gradually in the equipment, soil supplies varying in texture, variability in the individual and so on. How are we to tackle this problem?

Long experience may enable a grower to be sure of never overdoing the watering, and at the same time of giving the beds sufficient water to ensure regular crops year after year, assuming that he has mastered the other variable factors in mushroom cultivation, such as the quality of the manure, but, how can he know that he is putting the right amount of water in the soil? Let us suppose that he watered very heavily on one occasion, as an experiment. The crop may have failed immediately afterwards, or, if the watering took place before cropping, no mushrooms appeared. If the previous 20 or 30 crops had been reasonably successful, he would put the failure down to over-watering, although other factors may have been responsible. The compost might have contained one of the competitive fungi responsible for crop failures and have been doomed anyway. In some composts, the mushroom mycelium seems to hang on by a thread, as it were, and the slightest unfavourable condition wafts it into oblivion, whereas a strong mycelial growth should and does stand up to a lot of harsh treatment like any other form of life. However, the point is, that the grower is permanently scared off heavy watering, and his subsequent crops may suffer from a lack of water at the right moments.

On a large farm, divided into many units, there are times when disease and other troubles pile up, so that watering is put off for just that short period which makes all the difference, especially in hot, drying weather. At times like this, the aquaphobe cannot bring himself to give that heavier watering which would tide him over a longer period. In really dry weather, therefore, his customary light skim based on the little-and-often principle is back in the air of the house before he can get out of the door. An exaggeration, perhaps, but the water probably has not penetrated more than a quarter of an inch after it has had time to soak in to its limit. The base of the soil layer becomes increasingly dry, and only when the compost has a high initial water-content do mushrooms still continue to grow properly. Even then, dying pinheads may be the result.

Among articles dealing with watering which have appeared in these pages in the past, readers may remember a photograph of a bed showing mushrooms growing vigorously along a well-defined line in the casing of a bed. The sender stated that the line lay directly beneath

FIG. 1

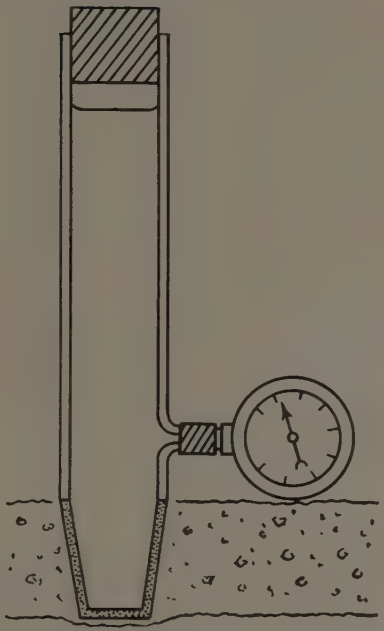


FIG 2: SOIL TENSIOMETER
(for compost readings the side tube would be higher up the main tube).

an overhead pipe, and that the strong growth there, with the rest of the bed showing no pinheads at all, was presumably due to the dripping of condensate from this pipe. Since he had watered the whole bed after the normal fashion, it would seem to be a reasonable pointer to the beneficial effect of that extra water supply.

A believer in sufficient water myself, I have had an even more convincing proof of the desirability of getting sufficient water into the casing from the start. Figure 1 shows a plan view of a bed, one of eight in a house which came into crop a short while ago. The beds were watered when the mycelium was well established in the soil, and appeared to be right according to hand tests made at the time of the appearance of the first pinheads. The house was more-or-less forgotten for a few days, and I happened to look at it very carefully when the first mushrooms were ready for picking. As the diagram shows, mushrooms were grouped behind each upright supporting the beds, and occasionally along a straight line bisecting the beds longitudinally. It did not take long to grasp the fact that, when watering, the rose has to be withdrawn on coming to a support and then inserted again, with the effect that a

double dose of water was likely to fall on the same areas behind each support. In the same way, since the beds have to be watered from both sides, the spray overlapped occasionally in the middle of the bed, resulting in wetter patches along the longitudinal bisecting line. Obviously the main watering had been too light. Additional water added to the unpopulated areas in each bay had the effect of bringing out fresh, strong growth in time for the first flush. Of course the expert wouldn't have made the grave error of watering twice on the same spot, but neither would he have discovered, as I did, that the mushrooms needed about twice the amount of water that they were given in the first place. I would add that the house in question has done extremely well since.

It is one thing to be convinced by an illustration of this sort, but how to profit by it without running the risk of over-watering? I hope I have found the answer, or at any rate, a very strong weapon to aid the grower, and I take this opportunity of describing a device which will enable the grower to read visually the water content of his casing soil.

There are, I imagine, several methods by means of which the moisture content of the soil might be measured, but until recently no one had produced a cheap, reliable instrument which could be used in quantity and left to give continuous readings, for it must be realized that, to be of use, each bed bearing casing soil should be equipped with an indicator. We have 80 beds bearing casing soil at any given moment, so that the instrument would be prohibitive if the cost were to go much beyond the shillings stage. An electrical instrument has been perfected that measures the moisture content in grain, but it is highly expensive, unsuitable for permanent installation in beds, and will not read above about 30% moisture content if I remember rightly.

Some months ago, I read an article in a horticultural paper on a device called a soil tensiometer marketed by an American firm. I wrote to the firm in question, whose director was most helpful in his reply. He assumed that the dollar situation would prevent us from buying one of their products, and very kindly forwarded blue-prints and full details of their tensiometer. The cheapest model retailed at the equivalent of about £5 10s. 0d. which, of course, would be out of the question.

The tensiometer consisted of a metal tube bearing a porous pot cup at the lower end where it is inserted in the soil. The top is sealed after filling with water, and the readings are given on a vacuum gauge connected to a side-tube in the instrument. In use, when the soil round the porous pot dries out, a tension is set up due to capillary action among the soil particles, water passes through the porous cup, and a reading is obtained on the vacuum gauge.

After some thought, I evolved an all-glass model (see Fig. 2) in which the porous pot was replaced by a sintered glass cup fused to a glass tube, and provided with a glass side-tube and a rubber bung. A prototype was made for me by a firm of scientific-apparatus makers, and this is now under test.

As a first test, the tensiometer was placed in the casing of a house which had just been cased with soil of average moisture content. The cup on this model being about 2½" deep, it was necessary to thicken the soil slightly at the point of entry, so that the porous section was

surrounded completely. This was, of course, essential to the proper working of the device.

A few days later, a reading of the gauge was taken, and daily after that. The gauge read inches of mercury, the full-scale reading being 30 inches or 1 atmosphere. At the first reading, the gauge showed 6·5 inches, the soil being just noticeably damp when tested by hand. Subsequent daily readings gave 7·5, 8·25, 9·75 and 10·75. Although the soil was still not too dry, a light watering was given, and some time later on the same day the gauge indicated 8·00 inches of mercury, showing a water-content somewhere between the first reading and the last. Subsequent daily readings were 8·25, 9·00, 9·25, 9·60 and 10·00, showing a fairly consistent and gradual drying out from day to day.

Now it must be understood that the readings are purely arbitrary, and a reading of 7 inches of mercury in one type of soil having the ideal moisture-content would not necessarily indicate a similarly ideal state in another type of soil. Intelligent observation and the relating of readings to individual conditions are required. The first and simplest calibration to be done is the observation of readings of the gauge, first with beds watered as heavily as the grower dares to do, and then with beds having a dry soil as indicated by the grower's own experience. With these outside limits as a guide, the ideal state of water-content could be determined by careful observations over a period. For example, particularly fruitful areas of beds could be tested as soon as healthy buttons commenced to appear, and it might be discovered that the readings taken over a long period and with many crops all lie between certain limits on the gauge. Other possibilities present themselves, such as the permanent mounting of a tensiometer with the porous cup immersed in the compost below the soil, with regular readings taken over the whole life of the bed from spawning to emptying.

One apparent snag will be visualized by some growers, who will point out that local conditions, types of houses and different methods of ventilation, etc., all lead to unequal drying-out of the casing soil. So much the better. Constant observation will have told the grower that certain parts of his beds conserve their moisture better than others. The procedure indicated here is to plant a number of tensiometers at regular intervals in a specimen bed and to take regular readings over a period of a few weeks. Any areas shown to be liable to quicker drying that the rest would be watered lightly and at intervals until readings were more or less in line, and a little calculation would indicate the approximate additional watering to be given under these special conditions. For normal work, based on these observations, one instrument would be mounted in the best position in each bed as judged by the individual grower.

Another apparent difficulty is that mushroom growth near the instrument would dislodge it, necessitating continual replacement elsewhere. If necessary this would not be a great hardship, but it should be possible to treat the small area of soil occupied by the instrument with a fungicide which would prevent mycelial growth at that point, and hence obviate the need for continual transference.

A good deal of work remains to be done before the device can be

passed as reasonably infallible, but it is my belief that it may prove to be more than a partial answer to planned watering. If the tensiometer does its job properly, the grower should be able to enter a house containing say, eight beds, and glancing at the gauges in a few seconds, determine without hesitation that this bed or that needs more water, or that none is needed, as the case may be.

In conclusion, I would point out to those growers who are also horticulturalists that the tensiometer was devised primarily for their use, and should be almost as useful in that sphere of operations.

Since completing this article, I have learned that a tensiometer, based on the same principle and mechanism as the one described, was produced before the war in this country, probably ante-dating the American example. However, it is hoped that the modified tensiometer will prove to be cheap and therefore available in quantity to the grower.

PRESS CUTTINGS

The best spawn is sold as a pure-culture spawn and . . . . . detailed instructions are sent out with the spawn, making mushroom culture nearly foolproof.

New Gardening Encyclopædia (Ed. Mollie Thompson), 1949.

The thirteenth Annual Report of the Land Settlement Association, covering the year 1947-48, records that the value of mushrooms sold showed an increase of £421. *Gardeners' Chronicle*, 26.3.49.

Princess Elizabeth presented awards at the annual meeting of the National Federation of Young Farmers' Clubs in London yesterday. She was wearing a *mushroom pink* two-piece suit.

Daily Telegraph, 12.5.49. (The italics are mine! Ed.)

Three-way spread of insecticide to give greater dispersion is a feature of the new pressure smoke generator just introduced by Plant Protection Ltd. In addition to the conventional top fuse, two at each side of the container permit smoke emission.

Nurseryman and Seedsman, 24.3.49.

The N.F.U. Glasshouse Produce Committee referred to a recommendation issued by the Ministry of Fuel and Power that potential users of automatic stokers should enquire into the availability of suitable fuel before installing this type of stoker.

Nurseryman and Seedsman, 24.3.49.

Two new types of spawn are being developed, but these are not yet on the market. One is grown on a compost of tobacco stems, the other on grain . . . . . Over 60% of the spawn produced at the Scottish Mushroom Laboratories is exported, most of it going to France, Belgium, Holland, Switzerland and Ireland. *Nurseryman and Seedsman*, 14.4.49.

On imports the Union's views (are) . . . . . that tariffs on horticultural produce should be adjusted to their pre-war incidence. This would mean that there would be no encouragement for foreign growers to glut already-overloaded markets, but imports would still come in at times of shortages when they were most wanted.

Horticultural Trades Journal, 19.5.49.

RESEARCH APPEAL FUND

ONLY £220 OFF THE TARGET

The Directors of the Mushroom Research Association are most gratified at the response of the Mushroom Industry to the Appeal for £2,500 to enable the Yaxley Research Station to continue its useful work.

About 100 Grower Members of the M.G.A. have not yet subscribed to the fund. Some are experiencing a difficult time at the moment—these are the Trouble Months—and others no doubt have overlooked the urgency of the matter. Nevertheless, as we go to Press the fund stands at £2,280, leaving only £220 to balance our accounts for 1949.

The contributions gratefully received since April Bulletin 15 are as follows :—

	£	s.	d.
R. G. Nelson	15	15	0
T. B. Brook	10	10	0
J. B. Cutting	10	10	0
G. M. McArthur	10	10	0
Mrs. Robertson (South Africa)	10	1	0
R. L. Allen	10	0	0
Ball & Luxmore	10	0	0
Boots Pure Drug Co. Ltd.	10	0	0
H. L. Coulson	10	0	0
H. H. Fell	10	0	0
R. H. Filmer	10	0	0
J. Hunt	10	0	0
W. Knight	10	0	0
L. Knight	10	0	0
G. A. Liddard	10	0	0
A. G. Linfield	10	0	0
London Co-op. Soc.	10	0	0
T. S. Menmuir	10	0	0
W. E. Mouland	10	0	0
B. O'Brien	10	0	0
I. W. Read	10	0	0
G. M. Riley	10	0	0
H. & C. Rochford	10	0	0
J. S. Soutter	10	0	0
K. C. Tewkesbury	10	0	0
G. Yates	10	0	0
Worthing Vineries	6	6	0
W. S. Atkinson	6	0	0
J. W. Knight	6	0	0
G. Bates	5	5	0
C. P. Chamberlain	5	5	0
E. A. Gook	5	5	0
R. Dermody	5	5	0
Ellwood Mushrooms	5	5	0
R. R. Howse	5	5	0
A. D. Sanger-Goldsman	5	5	0
Simons & Sons	5	5	0
C. & J. R. Webster	5	5	0
J. R. Ashton	5	0	0
H. Barraclough	5	0	0
F. M. M. Beerling	5	0	0
P. Dekeirel (France)	5	0	0
Elan Valley Products		0	0

	£	s.	d.
D. J. Field	5	0	0
Brig. Sir. G. Fisher	5	0	0
H. T. Gammons	5	0	0
R. Gilchrist	5	0	0
D. C. Herbert	5	0	0
J. A. Kemp	5	0	0
S. Kohn	5	0	0
D. J. Palmer	5	0	0
E. R. Peacock	5	0	0
A. Simkins	5	0	0
R. Speller	5	0	0
W. Thew	5	0	0
P. Thompson	5	0	0
Marchioness Townshend	5	0	0
J. Upton	5	0	0
E. S. Wildsmith	5	0	0
M. Wingfield	5	0	0
W. L. Chamberlin	4	16	0
G. W. Darnes	4	4	0
A. Parkes	4	4	0
J. Aspden	4	0	0
J. Z. Sala	2	10	0
C. R. Hockley	2	2	0
T. A. Smith	2	2	0
W. N. Stone	2	2	0
W. J. Trusler	2	2	0
H. R. Watt	2	2	0
J. W. Hartley	2	0	0
D. McCarthy	2	0	0
E. J. Woodward	1	7	0
Mrs. Bagshawe	1	1	0
T. B. Douglas	1	1	0
C. J. Hollins	1	1	0
D. B. Neale	1	1	0
W. Young	1	1	0
R. L. Scarlett	1	0	3
T. S. Collyer		18	0
	£485	11	3
Total brought forward	£1,796	8	11
TOTAL TO DATE	£2,282	0	2

200 ATTEND THE

KEEN INTEREST AROUSED BY SYNTHETIC FORMULA

Visitors from France and Holland

TWO HUNDRED VISITORS SPENT A MOST INTERESTING DAY AT YAXLEY ON THURSDAY, 5th MAY, ON THE OCCASION OF THE RESEARCH STATION'S OPEN DAY.

DR. BELS AND DR. EDWARDS examining synthetic compost

Details of importance in the preparation of M.R.A. Synthetic Composts were described by Dr. R. L. Edwards, Director of Research, who later answered many questions mainly concerned with these composts but also taking in the whole field of commercial mushroom growing. Charts displayed (*a*) the superiority of dried blood as a source of nitrogen, (*b*) the effect of high nitrogen content inincreasing the size of mushrooms, and (*c*) the relation between growth in diameter and weight (revealing very rapid growth as the mushroom approaches readiness for picking). Other illustrations demonstrated that (*d*) the best results were obtained with a low proportion of superphosphate, (*e*) earlier cropping resulted from adding gypsum, (*f*) increasing the depth of compost increased the size and number of mushrooms, and (*g*) close planting of spawn gave a more rapid start to the crop (it took more distant planting 16 weeks to catch up).

Mr. S. Burrows, M.R.A. Chemist, staged a demonstration to show what took place when hydrated lime and carbonate of lime were used to raise the pH of a slightly acid soil, and the further effects on treated and untreated soils when acid was

I.R.A. OPEN DAY

added to simulate the acidity produced during the mushroom's growth. He also showed how compost samples were prepared for analysis.

Miss C. W. H. Duncan, M.R.A. Microbiologist, showed specimens of mushrooms infected with *Verticillium* (brown spot), *Mycogone* (bubble) and *Dactylium* (mildew), compost attacked by *Papulaspora* (brown plaster), *Scopulariopsis* (white plaster), *Chaetomium* (olive green mould) and *Myceliophthora* (Verdigris). She also displayed samples of *Coprinus* (Ink Cap), *Clitopilus* (Cat's Ear) and *Clitocybe*, as well as mushrooms malformed by Rose Comb.

Mr. George Brown, M.R.A. foreman, showed visitors round the test houses and the compost shed, with its unique division into bays for the preparation of small stacks.

Miss Warman, Miss Barrows and Mr. D. Eaton assisted in their respective departments, and Miss Hill was in charge of the office.

The visitors included Messieurs P. Guichon and P. Dekeirel, President and Secretary, respectively, of the French M.G.A., with Mons. R. Chaumet ; Dr. P. J. Bels, Holland ; Dr. E. M. Crowther and party, Rothamsted Research Station ; Mr. E. Skillman, Provincial

Left to right : Messrs. Fred. C. Atkins, B. A. Noble, McG. Bulloch, P. Dekeirel, Dr. P. J. Bels, P. Guichon, R. Chaumet, Lady Leese and Sir Oliver Leese.

Glasshouse Adviser, and Dr. N. H. Pizer, Advisory Soil Chemist, Eastern Province, N.A.A.S.; Mr. A. D. Harrison, Provincial Glasshouse Adviser, and Mr. H. H. Glasscock, Advisory Mycologist, South-Eastern Province, N.A.A.S.; Mr. J. Lamont, Assistant General Secretary; Mr. H. R. Haynes, Horticultural Secretary; and Mr. A. G. Sellars, Assistant Secretary, N.F.U. Headquarters, and representatives of every firm of note associated with the Mushroom Industry, also spent some hours at Yaxley during the day.

Parties visited the farm of Noble Mushrooms Ltd. during intervals in the M.R.A. programme, and were conducted round by Mr. B. A. Noble, Managing Director, assisted by the charge-hands. Many were the comments on their strict Rules of Cleanliness. Below are seen Sir Oliver Leese and the Chairman of the West Sussex branch of the N.F.U. (Mr. A. DeB. Hovell) admiring one of the beds on this farm.

The French party wrote later to General Sir Oliver Leese, Chairman of the M.G.A. and the M.R.A.: "We were very interested in the Research Work which you showed us at your Station and by the remarkable mushroom-growing demonstration by Mr. Noble. I hope you will be very kind and pass on our grateful thanks to Mr. Atkins and Dr. Edwards for the great trouble which they took in showing us all the interesting work which they were doing. Will you please tell Mr. McArthur and Mr. Chamberlain how grateful we were to them for assisting us in our journey to and from Yaxley: It was a great pleasure to us to meet them. *We are convinced that visits between British and French Mushroom Growers are of the greatest value to the progress of our mutual industry and also to the cordial relations which now exist between our two countries.*"

Many other letters of appreciation were received, of which these are typical. To Dr. Edwards: "From the moment of our arrival, when we

were so courteously welcomed in the office, we found much of great interest to us. All the discussions with Dr. Edwards, Mr. Burrows, Mr. Brown, in fact all the Staff, were to us very helpful, and our visit was well worth while." And to Mr. Fred. C. Atkins, Technical Director of Noble Mushrooms Ltd. : " I am writing to thank you for allowing my foreman and myself to see around your farm on M.R.A. Day. All your folk were extremely helpful and answered visitors' questions without any of the ' caginess ' of many growers."

The arrangements for the day, which included the provision of lunch in three sessions, were made by the Secretary, Mr. Angus Watson, who has received so many congratulatory messages that modesty forbids him, as Editor, from quoting !

The Trade Press attended and gave excellent reports of the day. We cannot conclude our own summary without a quotation from a leader in the *Nurseryman and Seedsman* (12.5.49) : " The evolution of (the M.R.A. Compost), giving adequate yields at a cost comparable with the use of horse-manure, is obviously a development of the highest importance. Conversations with French and Dutch experts who attended the demonstration indicate that this is a direction in which we have gained a substantial lead over continental workers, and that in other aspects of commercial cultivation, spawn manufacture and pest and disease control, our scientists are also keeping us in the forefront. We congratulate the Mushroom Industry on the success of their struggle to improve their status and gain official recognition. Much as has already been done, there remain many knotty problems still to tackle, and these can only be solved through continuing co-operation amongst growers and whole-hearted support for their organisations."

Those Thin-Stemmed Mushrooms

Noel D. Harding makes some suggestions

We all at some time have had a crop which will only grow long, thin-stemmed mushrooms no matter what we do to encourage it. We raise the temperature, we increase the humidity, we change the air more frequently, we spray the beds with a salt solution, there is neither insect damage nor disease which we can detect, mycelial growth is good. What is the cause of these long, thin-stemmed mushrooms ?

ONE OR A COMBINATION OF THE FOLLOWING WOULD INDUCE THE ABOVE-MENTIONED TYPE :

Dung which has been composted and surplus to a previous filling, has been mixed with the next consignment of fresh dung, turned with it and used to fill the following house. The compost has been turned 6 to 8 times making it useless for mushroom growing. It is very tempting to mix old compost with fresh dung, especially if there is much more than is required, but as it is detrimental to spawn growth it is better to discard it and cut the loss.

The moisture content of the compost during filling must be such that after peak-heat it has almost adjusted itself. If the compost is still wet the house must be kept in heat longer to drive off excess moisture. If the average bed temperature doesn't rise appreciably the compost

is too wet or too dry. If it is too dry it will be impossible to add enough moisture at this stage. In either case mushrooms will grow sporadically, will produce long, thin stems and break their membranes quickly with consequent loss in weight.

Soil plays an enormous part in crop production and it is probably one of our chief causes of partial crop failure.

Type and depth of soil and firmness of cased beds have also to be taken into account. Depth of soil will vary with type and some of the heavier soils don't need firming.

I prefer a mixture of peat and a medium soil and a very light firming. The addition of peat produces rather an acid reaction, but this can be overcome by the addition of lime. As the mycelium requires an abundant supply of fresh air the peat will prevent any sealing off from the compost of this air.

Mycelium will run best in an alkaline soil—pH 7 to 7·5.

Strain and vigour of spawn growth within the first two weeks of planting is a very important factor. There is one strain of spawn which produces small, thin stemmed mushrooms irrespective of what treatment the beds and house receives. I have proved this to be so time and again against another strain. Both strains had exactly the same treatment throughout the cropping period.

In my opinion a good spawn must be vigorous, must be capable of producing large, heavy mushrooms at a temperature of 56° F.—60° F. for two months. These things are governed, of course, by correct composting and general management, but not all strains will produce this type of mushroom.

Air temperature and humidity also must be taken into account. Low air temperatures (54° F.—58° F.) produce the best mushrooms and a longer crop, while temperatures over 60° F. usually produce rapidly opening, long, thin stemmed mushrooms with consequent loss in weight and a shorter crop.

It so happened that I met a grower the other day who had this very same trouble, so that I was able to investigate thoroughly.

The dung was a mixture of ' short ' and racing stable. The compost which I saw was quite well composted and the mycelial growth throughout the compost was very vigorous. The beds were cased with a mixture of peat and a medium soil. Pinheads appeared a fortnight before schedule. But as soon as the beds started to produce in quantity they were all thin-stemmed and opened out rapidly. This state of affairs continued throughout the first, second and third flushes and still continue to do so. The crop had been run in the normal way until it was noticed that the mushrooms were going to be small. Then the air temperature was further reduced and more ventilation was given. Small mushrooms appeared in spite of this extra ventilation, etc. All mushrooms grown in this house previously were large and produced thick stems.

I am of the opinion that racing horses have had a change in their diet and consequently there is very little food value to promote mycelial growth especially after a heavy ' flush.' Are these racing horses dosed ? If the answer is in the affirmative then the dung will be unsuitable for mushroom growing.

CORRESPONDENCE

I am off to Southern Rhodesia ! Before vanishing I would like to put on record my deep appreciation of the untold value I have had from the M.G.A. It seems hard to realise how pre-1945 mushroom growers existed without it, especially newcomers to the Industry. It is as a newcomer that I am writing, for I only became interested in mushroom-growing at about the same time as the M.G.A. was born, and I have found it a permanent pillar of strength to lean upon. It imparts to the grower a never-ending spate of instructive information to a great extent by means of the Bulletin, and also by the interchange of visits and of knowledge amongst its members direct with one another. It provides a source of new personal contacts and friendships the value of which cannot be measured in terms of £ s. d. CAPT. M. E. FEW.

It has been suggested by several growers that at present they have neither the desire nor the need to grade, in fact some go so far as to aver that it would greatly increase their labour costs and disorganise their Packing Department ; such reasoning is ignoring the changing state of the market. I am convinced that this short-sighted policy is due to the continued profitable market for any quality mushroom consigned to the industrial area where the trade is not so discerning ; however, this state of affairs is slowly but surely giving way to sterner times and therefore is it not time for us all to earnestly consider an improved method of marketing in readiness for keener competition ? If this subject is studied from the Salesman's angle rather from that which is more convenient to the grower, then I feel that by packing and grading according to the Saleman's advice as to what the buyer requires, is the only means of ensuring the best prices for our consignments in competition with the imported produce which is sure to increase. We must also remember the existence of Government Marketing Acts and if we fail to " put our house in order " the day may dawn when unpalatable regulations are thrust upon us. W. A. B. HARDING.

We have just received a letter from the Acarologist at the Natural History Museum in which he states the " Instruction in identification of mites is not a subject which is taught at any Institute in the world and as there are so many genera it would be difficult to advise you on the matter of acquiring the necessary knowledge to enable you to identify them yourself." All of which is very discouraging, but we still feel that there must be a whole lot of information available somewhere if one could only get hold of it. HILARY N. BALL.

CHANGES OF ADDRESS

GROWER MEMBERS

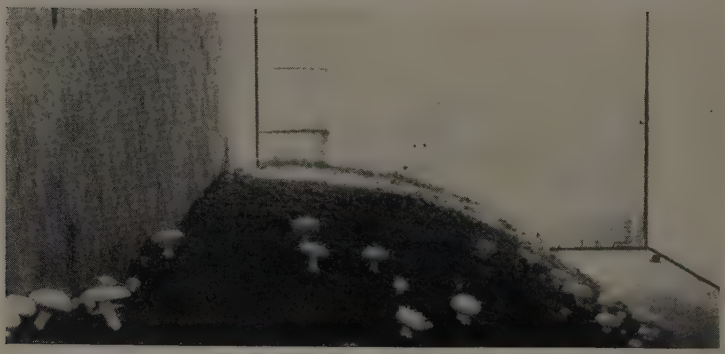
Lt. Colonel M. McLellan	Elan Valley Products Ltd., Rhayader, Radnorshire, Wales.
M. B. Blount	Postlands, Nr. Horsham, Sussex.
W. Sleight	7a, Tavistock, Townshend Road, Wisbech.
W. B. Bentley	Pannal Hall, Pannal, Harrogate, Yorks.

HON. (ED. & ADV.) MEMBERS

A. D. Harrison, N.A.A.S. Sub-Centre, Wye, Ashford, Kent.

Sweating Problems with Concrete

R. H. T. GIBBENS EXPERIMENTS IN AIR-RAID SHELTERS



It is said that almost any building can be used for growing mushrooms, but many buildings will prove to have disadvantages which are not apparent until the experiment is tried out. The purpose of this article is to show the problems which arise when growing in underground air-raid shelters.

The three buildings used in this case were concrete, 30 ft. × 6ft. × 7 ft. high, the floor level being 6 ft. below ground and the roof covered by 3 ft. of soil. A doorway was at one end and an 18″ escape hatch at the other. The aim was to make 400 sq. ft. in 3 ground beds.

The experiment was first tried in the winter of 1947, when the sub-zero temperatures then prevailing were not thought to be suitable for composting in the open. The muck was therefore dropped down the escape hatch and composted in the shelter. As the pile heated up, the steam rose to the cold ceiling—condensed, and fell back onto the pile—causing it to become almost hopelessly wet. However, the beds were laid, spawned, and two were cased. The third bed developed such a bad attack of White Plaster Mould as to be a complete write-off.

It was found during the following summer that the air temperature of the shelters did not rise above 65° F. but that any rise even as small as 2° caused the concrete walls and roof to sweat badly—the moisture on the ceiling falling into the bed with disastrous results. The excessive moisture coupled with the poor ventilation gave rise to Plaster Mould, Bacterial Pit and Verticillium and few mushrooms were produced.

The following winter muck was composted in the open for 400 sq. ft. in one pile aiming to have the compost a little drier than normal. Compost was dropped down the escape hatch and beds were laid 12″ thick on the floor and spawned on Christmas Day. A very light casing soil with poor moisture-holding capacity being used, watering was only done when the weather forecast predicted cool weather and then only 1 gallon per 75 sq. ft. If a spell of rising temperature coincided with a flush on the beds, the mushrooms were picked off as quickly as possible.

The escape hatch was kept fully open and protected by a sheet of corrugated iron and a ventilation slot 8″ deep covered with perforated zinc opened at the bottom of the door. One bed was again attacked by White Plaster Mould, but the spawn growth overcame this eventually, though the yield of this bed was considerably reduced.

No heating was used at all during this period of May to September, 1948. The total yield = 460 lb. (i.e., 1·15 lb. per sq. ft.)

To increase the bed area by means of trays or racks would undoubtedly mean greatly increasing the ventilation, since it was found that unless the shelter door was wide open for at least 2 hours daily, the mushrooms developed long stalks and small heads. This condition was cured by fixing a tarpaulin sheet over the escape hatch in the manner of a wind scoop. This method was also used to try to raise the shelter temperature quickly during the early part of the year. The result seemed to suggest that the concrete had absorbed a certain quantity of water and that this had to come out anyway and it was better to release it fairly gradually than in a heavy rush for 24 hours.

To sum up, it would seem that ventilation coupled with the peculiar sweating nature of concrete give rise to very great problems.

Modern Mushroom Farm from W.D. Surplus

ONE BLOCK at
TENTERDEN MUSHROOMS LTD.
(HARDING BROTHERS)

13,000 sq. ft. KEY TO LAYOUT 1948
(Reading Left to Right)

In Foreground :—

Soil Store and Sterilizing Shed ; Composting Shed (Barn of sturdy construction owing to exposed site—not W.D. surplus).

Back Row (range of buildings) :—

No. 5 Growing Shed ; Packing Shed, Office & Store ; No. 4 Growing Shed ; No. 3 Growing Shed ; Main Boiler House ; No. 2 Growing Shed ; No. 1 Growing Shed ; Soil Store ; Pasteurizing Room and Steam Boiler Room ; Implement and Tool Sheds.

Electricity in Mushroom Houses

Dr. P. J. BELS PROVIDES SOME DATA

Several questions have been asked recently which reveal an increasing interest in the use of electricity in mushroom cropping houses, and the following notes have been contributed by Dr. Peter Bels, M.G.A. Honorary Member in Holland, amplifying what his wife had to say in Bulletin 15 on this subject ("Swiss Mushroom Growers," p.94).

The Swiss growers believe that mushroom mycelium grows best at a rather high temperature, whereas fruiting is best at a lower air temperature. With the soil heating system these conditions can be maintained throughout the cropping period. It is strange that until now the air in mushroom houses has always been heated, so that these ideal conditions have been reversed. It is particularly noticeable when floor beds are grown in glasshouses.

Swiss and Dutch technicians disagree about the relative merits of low voltage and mains voltage for soil cable heating. A new plastic covered cable is used for soil heating with 220 volts. Electrical heating has the great advantage of immediate control but the choice also depends on the cost of coal and electricity.

At Mr. Banninger's installation in Switzerland the soil heating was normally used on alternate nights only, the bed temperature was about 60-68° F. and the air temperature 55-60° F. Condensation was controlled by running heating cable along the most exposed walls and ceilings. The humidity of the air was higher than is usually found in English mushroom houses ; there was no other heating.

It is very important with soil heating to have a damp layer between the heating system and the compost to avoid drying of the bed. Care is necessary to prevent over wetting. We have no details of the current consumption in Mr. Banninger's beds, but each bed of 26 ft. × 2 ft. has 4 galvanised iron wires ; the rate of heating is controlled by varying the voltage between 14 and 24 volts.

We are trying the method in a very simple form. On 65 sq. ft. we have 100 ft. of plastic covered cable working on 220 volts and using 900 watts. This is switched on from about 11 p.m. to 9 a.m. The cable is embedded in wet sand under the compost. At the sand/compost inter-face the temperature at 9 a.m. is 68-75° F. and at 5 p.m. 65-70° F. Air temperature at the surface of the bed is 54-61° F. If the air temperature is too much below that of the sand, condensation occurs in the top of the compost or in the casing soil and the beds become too wet.

The electricity consumption depends on the surrounding conditions and with sand on a tile floor we have a considerable loss of heat. More current is used during the spawn run than during cropping.

The following corrections must be added to the article by Dr. Bels-Koning on Mr. Banninger's system.

The heating wires are galvanised iron instead of copper, and since alternating current is used the water surrounding the wires also carries some current, and the distribution of heat is very even.

The insulation underneath the heating cable is probably unnecessary, as the downward loss of heat will be small in any case and will help to warm the air a little.

The article said that alkalinity might be harmful, but our experiments have since shown that high alkalinity is favourable up to pH 8·9 in ground Tuff which has a water capacity of 31% by weight on the wet weight.

We tried an artificial casing with pH 5·8 to 8·2 and 8·2 gave the best results, but these experiments must be repeated with a higher range of pH.

COLLOIDS: WHAT ARE THEY?

S. BURROWS TO THE RESCUE

During those happy, carefree days at school when we were not concerned whether mushrooms grew on trees or were made at the local gasworks, so long as there were some for breakfast occasionally, we were told that all matter could be classified as solid, liquid or gas. Solids were hard impenetrable substances and liquids took up the shape of the vessel in which they were put. This works all right for sugar, water, mercury, iron and similar substances, but the classification of custard, glue, mud or froth into one of these three states of matter is an awkward problem. To overcome this, these sticky, gluey and slimy materials are called "colloids."

Colloids consist of a very intimate mixture of two or more substances that do not ordinarily mix and they have quite unexpected properties. For instance, bitumen and water will not usually mix but when bitumen is broken up in a special machine into minute particles of less than 1/100,000th of an inch in diameter, it will remain suspended in water especially if a little "stabiliser," such as soap, is added. The mixture is then called an emulsion and it can be transported and poured on to the road surface without heating it. When granite chips are brushed over it the emulsion is "broken" and the bitumen recovers its sticky properties. Other examples of colloids are tar oil winter wash, milk, salad cream and the dark liquid which sometimes oozes from the bottom of a compost heap. The secret of the stability of these mixtures and also their unusual properties lies in the extremely fine state of division of one or more of the constituents.

If clay soil is mixed with water and poured into a glass tumbler the stones and sand will quickly reach the bottom and the fine silt will settle in an hour or two, but the clay will take days to reach the bottom. This is because the clay particles are so very small that they are comparable in size with the molecules of water (only a few hundred times larger, perhaps). These molecules are in constant, rapid motion and continually jostle the clay particles in all directions so that they have little chance of falling under their own weight. The smaller the clay particle is, the greater is the ratio between its surface area and its weight so that it will receive relatively more bumps from the water molecules and so remain suspended longer. The clay particles also bump each other sometimes and if they rebound like billiard balls all is well, but if they stick then a larger particle is formed and if this process continues the particles grow larger and eventually sink. This process is called "flocculation" and is what happens to clay soil when lime is added to make it more friable.

Turning to compost, which is of more immediate interest to us, we find that colloids may form an important part of the finer material. This finer material is necessary in a compost since it confers upon it greater compactness and greater moisture-retaining properties. In addition it has a large surface area in proportion to its weight and thus it can be more readily attacked by the growing mushroom mycelium. Sometimes, however, this fine material becomes cemented together by the colloids and a sticky, sour, anaerobic compost results.

These colloids are minute particles of insoluble organic material of a complex nature suspended in water. Since they are all negatively charged they repel each other and do not coalesce when they bump together. When gypsum (calcium sulphate) is added, some of it dissolves in the water and splits up into positively charged calcium particles (or ions) and negatively charged sulphate ions. The calcium ions become attracted to the organic particles and their charges neutralise each other giving an uncharged particle. As soon as this bumps another uncharged particle it will not rebound now but sticks, and so flocculation starts and the pasty colloidal suspension is soon destroyed. Its power of cementing together the fine material in the compost is lost and a more friable medium results.

This simplified picture does not explain why compost appears to be drier after adding gypsum, and we cannot say with certainty why this is. At first sight it seems that compost should appear to be wetter after gypsum has been added. The original suspended colloid particles hold water very firmly but after they have absorbed calcium ions they contract and throw out water so that more " free " water should be present. However, it may be that the coagulating particles trap water between them and although it would not be so firmly held as before it would probably resist squeezing out in the usual test for wetness by squeezing in the hand.

Accumulated experience since Pizer introduced the gypsum treatment has shown that it does in many cases produce a more friable compost and so allows the penetration of air to every part of the compost, thus producing healthy and rapid spawn growth. Whether this explains the whole of the beneficial effect of gypsum we do not know ; Treschow thinks otherwise.

A word of warning, probably unnecessary for most, must be added. Gypsum will not correct *all* greasy composts. If the manure is too wet in the early stages of composting, air is excluded and anaerobic fermentation takes place with the production by the anaerobic bacteria of sticky, gummy material which may not be coagulated by gypsum.

Mushroom Research Association Ltd.

BIGGER & BRIGHTER BULLETINS?

These Bulletins become larger and better. It takes me weeks to digest the information in them. And then some members think they aren't getting enough for their yearly subscription. It's astounding.

NOEL D. HARDING.

(*The Editor would appreciate ideas for further improvement*).

FRED. C. ATKINS thinking aloud . . . . . .

ANY EELWORMS?

I have been having a most interesting discussion by correspondence with Dr. James Sinden about eelworms.

In March, 1947, we were alarmed at Yaxley to discover a steadily increasing area of one bed going out of production. The soil appeared to be knitting together, but what aroused our suspicion was the dying of the mycelium in the bed. The compost was becoming dark and soggy, and it was evident we could expect no more mushrooms in this patch.

The microscope has a number of uses on a mushroom farm and in this instance it was able to tell us what had gone wrong: **The compost was positively seething with eelworms.**

We were able to stop the trouble from spreading by channelling across the bed five feet in advance of the dead area in both directions. A similar attack took place in May of the same year, in another house, and prompt channelling restricted the infection to a few square feet.

Not long afterwards a friend of mine had a very nasty attack which practically ruined his crop. Are eelworms a widespread pest of mushroom beds? I do not recall any grower complaining about them -but is that because they are so tiny? Let me quote from Professor Thomas, the American Entomologist and M.G.A. Overseas Member, writing in Pennsylvania Bulletin 419: "**. . . Immense numbers of extremely small, threadlike, whitish worms which have a constant undulating or wavy motion. They are much smaller than fly larvae.**"

In 1942, eelworms (or nematodes, or roundworms) were rated as a serious pest in the Mississippi valley, but not in Pennsylvania, the centre of the U.S. mushroom industry. To-day this problem appears to be reaching serious proportions in America, however, and the Pennsylvania M.G.A.'s technical adviser, Mr. George Mitchell, is now engaged on a survey of mushroom houses in Chester County to find how prevalent the nematodes really are, and how great an infestation is necessary to cause significant losses to the mushroom crops. Ought we not to do the same?

I know of three cases during the past two years, two of them very serious indeed. Have **you** noticed recently that your spawn died back and became a soggy mass? Have **you** had any mushrooms recently turn brown and watery, prior to complete disintegration --which is another form taken by eelworm-attack?

I hope you will report any such cases to me –and if in doubt send samples to the Mushroom Research Station, where Dr. Edwards and Miss Duncan are ready to co-operate in this survey.

Professor Thomas believes nematodes enter mushroom houses either with the manure or with the casing soil, and gives this comfort: "They are killed at comparatively low temperatures (below 125° F. for 30 minutes)." Here, then, is one more reason for pasteurization after filling; and if that is done properly, and eelworms still appear, we must look at our casing soil more carefully.

I shall have more to report –of real interest –in a few months' time. Until then, please keep an eye open for eelworms–and let me know at once if you find any.

COMPETITION FROM

SCOPULARIOPSIS FIMICOLA
(Cost. and Matr.). Arn. and Barthelet

Alternative Names :

White Plaster Mould, White Plaster, (Flour Mould?)

Characteristics :

White patches resembling crumbling plaster appear on exposed surfaces of compost or, as frequently, on soil soon after casing, and on maturing turn a delicate pink.

Original Source of Infection :

The fungus is probably introduced by air-borne spores, but flies may also be responsible.

Prevention :

Avoid under-composted or greasy manure. Do not case when surface of bed is very wet. Spores present at filling do not survive peak heats of 120° F. Pointing found 14 lb. superphosphate to the ton of fresh manure prevented any attack.

Control :

Isolated attacks can be ignored if spawn-run is vigorous. Pointing suggests watering with 1 lb. superphosphate per gallon of water. Larger areas infected should be saturated with one part 33% acetic acid to seven parts water, and removed. Widespread attacks are infrequent, and when they occur it is perhaps wisest to cut one's losses and throw out the entire house after raising temperature to 120° F. and holding it there for several hours.

Description of Organism :

Mycelium colourless, septate, little branched, 2-5μ in diameter. (In pure culture the sporiferous filaments are first in groups of 4 or 5, and the groups are separated from each other by a long portion of sterile mycelium.) The sporiferous filament is at first simple and fruits at its extremity, soon branching irregularly, each branch producing a chain of many spores. The fruiting filaments vary from 50μ to 100μ, are cylindrical at the base and the same size as the mycelium, diminishing gradually toward the extremity.

After Costantin and Matruchot.

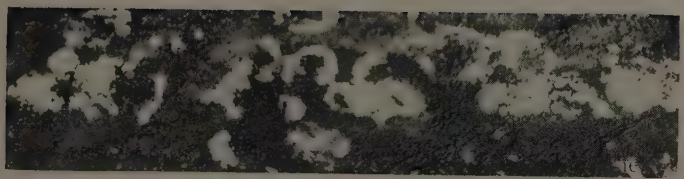
Spores 6-10μ × 4-8μ, globose, globose-oval, most commonly truly oval (broadly elliptical), one end being very obtusely rounded and the other slightly less so, and drawn out into a small truncate apiculus. This apiculus is at the end of the spore which was attached to the fertile branch, and it evidently persists after younger conidia have been formed between it and the conidiophore.

After Ware.

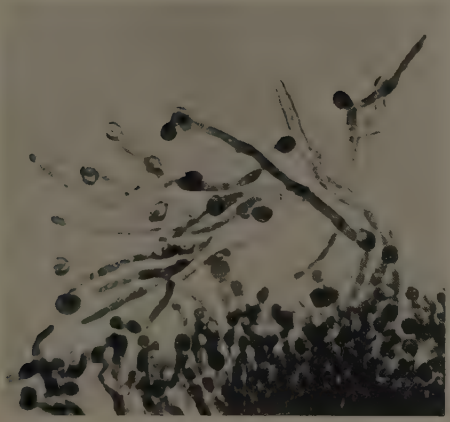
The U-shaped dichotomous branching of the sporophores is characteristic.

Charles and Lambert.

Fred. C. Atkins.



White Plaster Mould on a cased bed. (*A. G. Pointing*)



Phialides of Scopulariopsis fimicola × 500
(*G. Smith*)

Spores × 1000
(*G. Smith*)

Two diagrams after Costantin and Matruchot's original plate

Dr. R. L. EDWARDS, Director of Mushroom Research, reviews present-day knowledge of

MUSHROOM CASING SOILS

Some form of casing, usually soil with or without additions, is always used on mushroom beds, and is practically essential, though mushrooms do sometimes grow on uncased compost. It is universally agreed that the casing soil can make or mar a crop, but no one has yet shown what the soil really does, or what properties distinguish a good from a bad casing. It has at least these three functions -to support the mushrooms, hold moisture, and allow passage of air.

Recommendations in the standard books on mushroom culture vary. They agree that a good loam is suitable and that it should not be too light or sandy, but some put clay loam first while others prefer less clay. Very heavy soil or pure clay is generally condemned, mainly because it cakes when wet and cracks on drying. Organic matter is desired by some writers for its moisture-holding properties, but too much encourages the growth of other organisms and depresses mushroom yields. It is agreed that the pH should be near 7, and it may vary a little either way. Lime may be added if the soil is too acid.

The use of subsoil has one undoubted advantage in its presumptive freedom from disease organisms, and it is widely used in Great Britain, probably for this reason. American growers prefer surface soil which they normally 'sterilise' with steam, formalin, or occasionally other disinfectants, and some American writers condemn the use of subsoil. The use of formalin is increasing, because some soils are easily spoiled by over-steaming. They consider that some humus derived from plant growth is necessary.

Published research on casing soils has shown that soil can be improved by various supplements, without teaching us much about the fundamental principles. Bewley (*Ann. Rep. Cheshunt. Res. Stn.* 1946) has described experiments in which the addition of sand, stones, or peat to a light loam raised the yield from 2·45 lbs. per sq. ft. to 3·66, 3·13, and 3·32 lbs. per sq. ft. respectively. In another experiment a heavy brick earth free from organic matter gave a better yield than did light loam or heavy soil, both containing organic matter. Writers who favour soil containing organic matter say that it is needed to hold moisture, and it would appear from this experiment that if the soil alone can do that, organic matter is not needed for any other purpose.

USE OF PEAT :

Bewley found that mixing peat with his soil increased the yield; this is a fairly common practice, and peat is widely recognised as a good absorbent for moisture. However, in *Bulletin* 532 (1936) *of the U.S. Department of Agriculture*, Feustel and Byers reported experiments which showed that this is not the whole story. Peat and its mixtures with soil held more moisture than did soil alone, but starting from saturation they lost moisture by evaporation more rapidly, and the addition of

peat was much less effective in preventing wilting in plants than might be expected. This does not mean that peat is useless in a mushroom casing soil. Humidity is generally fairly high in mushroom houses, so that evaporation is slow, and peat also has a considerable aerating effect by keeping the soil open and preventing caking. But water should not be withheld in the belief that the peat retains several times as much water as plain soil would. Sand to open up heavy soils, and lime to raise the pH are commonly used, and ashes are sometimes added to improve the texture. Incidentally the buffering effect of lime may be as important as its immediate effect on the pH. Soil raised to pH over 9 with lime soon falls to about pH 8 owing to absorption of carbon dioxide from the air. There is continuous formation of acid during the life of a mushroom bed, causing the soil pH to fall, and this may eventually diminish further cropping. Lambert and Humfeld (*U.S. Dept. Agriculture Circular* 509, 1939) say that the yield is reduced on casing soils of pH below 5·5. A well-buffered soil can absorb the acid produced by the mushroom with little fall in pH. Carbonate of lime (ground chalk or limestone) is safer than lime for this purpose. If lime is used the soil should be allowed to stand for a few weeks before use. We do not yet know enough about the rate of production of acid to recommend definite quantities but the point deserves attention in future work on casing soils.

Pizer and Leaver (1947, *Ann. Appl. Biol.* 34, 34 ; *M.G.A. Bull.* 9, *October*, 1947) have reported experiments of which some completely baffle explanation. They described the cropping behaviour of four classes of soil, and an interesting point is that not only did the better soils produce more mushrooms, but they grew from pinheads to maturity more rapidly. Productive capacity was not related to any of the usual characteristics of soil fertility or structure. Very acid soils could be improved by liming, but not sufficiently to give a first-class yield.

Surprising results were obtained when they cased with two layers of different soils. In each case the yield was determined by the quality of the upper soil, and they comment on the ability of relatively sparse mycelium in a lower layer of poor soil to feed the more vigorous strands and the mushrooms produced on a good top soil. Several of the soils tested had characteristic forms of mycelial growth. Similar crops were obtained in some cases from soils in which different types of mycelial growth prevailed so that the form of mycelial growth is not the only controlling factor. In experiments on mixtures, adding $2\frac{1}{2}\%$ of one soil to another of different type greatly altered the form of mycelial growth, and the crop. They consider it probable that fruiting depends on access of air to the soil or to the mushroom strands. Their paper is important to research workers, but their conclusion that the only method of assessing the value of a casing soil is by small scale experiments (or of course in actual use) does not make things much easier for the grower.

Recently I examined a horse-manure compost which was producing a very poor crop, in which much of the spawn had grown into thick white strands near the bottom of the side boards. A large number of mushrooms grew out of the bottom of this compost and appeared to

be associated with the strands. It is common knowledge among mycologists that many fungi in pure culture spore most freely when subjected to partial starvation, and a similar condition is widely observed in plants. This starvation effect may be related to the fruiting stimulus of casing soil, the growth of mycelium into strands, and the appearance of mushrooms directly on a faulty compost.

I have often been asked about the prospects of finding a synthetic casing material. Expense must limit the choice of material for this purpose, and as some mechanical strength and bulk are necessary to support the mushrooms we are almost certain to come back to soil as the basis of our casing. That being so, the problem can be more precisely stated. It is to find out what properties are required, and to modify a wide range of different soils to give all of them those desirable properties.

Investigations on the practical side alone are unlikely to carry us very far, because it is well known that many different soils respond to different watering treatment, each giving a satisfactory crop when suitably managed. A soil known to be good often gives bad results in the hands of a grower who is used to watering his own soil of a different type. A direct comparison between two different casing soils, or other casing materials, therefore, involves either the risk of watering in a way which suits one better than the other, or the necessity of finding and applying to each the method of watering which suits it best. The former alternative may give misleading results, and the latter is an unwelcome complication difficult to put into practice.

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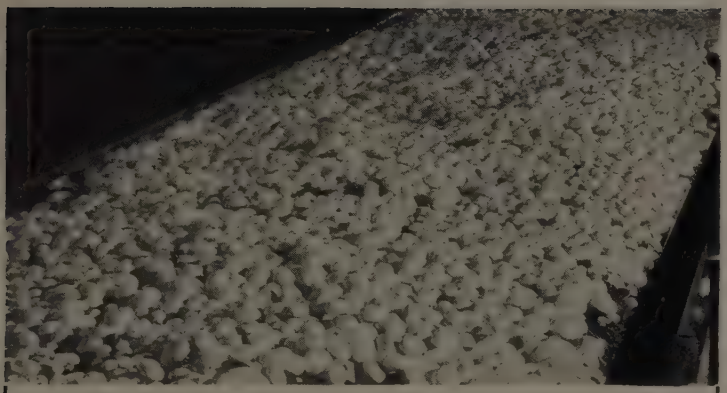

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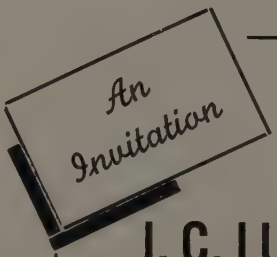

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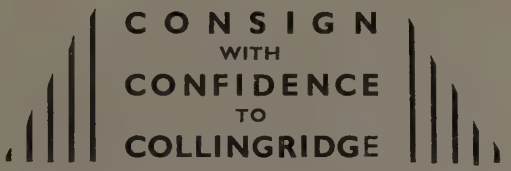

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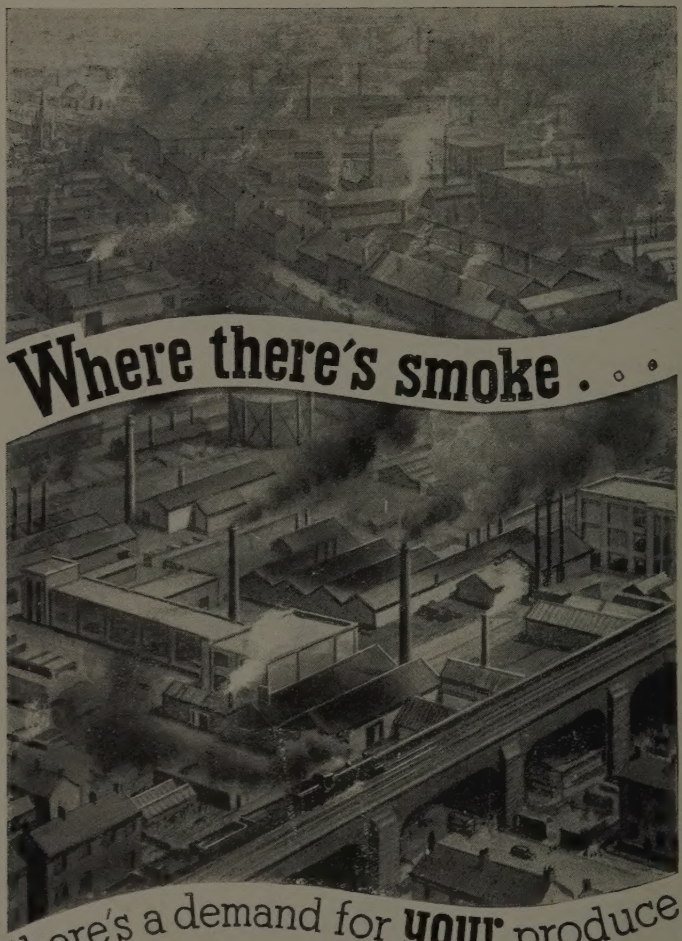

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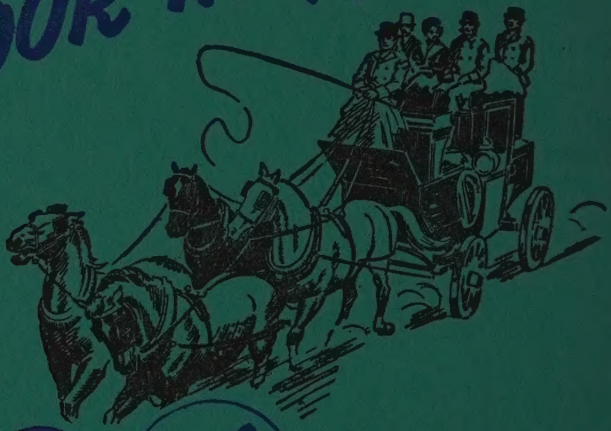

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